Chapter 10 – Comparing Groups with t Tests and Similar Nonparametric Tests

Using the College Student data file, do the following problems. Print your outputs after typing your interpretations on them. Please circle the key parts of the output that you use for your interpretation.

10.1. Is there a significant difference between the genders on average student height? Explain. Provide a full interpretation of the results.

In this case the first question to ask yourself is whether the dependent variable (student height) is normally distributed. You can find this by running either a frequeincies or descriptives test. Based upon this finding, you can determine which statistic to select from the SPSS menus. If it is normally distributed the independent t-test is the test we recommend. If the dependent variable is not normally distributed, then the Mann-Whitney is the better choice. How do you decide what normal is?

If the skewness from the descriptive or frequency printout is equal to greater than one, then we recommend using a non-parametric. If it is less than one (say .87) then you would select the parametric statistic (in this case the independent t test).

With difference tests it is very important to review the descriptive table in the printouts. First, review the means. Does it look like there is a large difference in the means? This process will let you estimate what the difference statistic (parametric or non parametric) and sig values should logically be. Similarly, the standard deviations tell you whether there is a small difference in the distribution of scores or (just by eye balling it) is there a large difference. You should find that when there is a relatively small difference between means, the t or Mann-Whitney sig column should show a large sig. value. Usually there is a high chance of getting these results by chance. In other words, statistically speaking, there is little change that there is a real difference in the means. More importantly, there is little difference that the independent variable was the reason for the outcome.

This case gets a bit more difficult because there is a large difference in the standard deviations of two levels of each the independent variable. One has a value of 2.80 and the other 2.07. Although that might sound confusing, SPSS makes it easy for you. If the distributions are significantly different than you read the bottom line of the SPSS printout. If the distributions are like most, (not a large difference between the standard deviations) then you read the top line (equal variance assumed). If there is a big difference the Levene's test will tell you that in much the same way as every test we have discussed. If there is a p or sig value less than .05 then there is a difference between the two distributions.

This concept is one of the most difficult to understand in this chapter. It's easy to run the statistics, but can be difficult to read the outputs. Look first for if the Levene's test is significant or not (note the headings on the top of the table). THEN you interpret the "t-test equivalence of means" columns. If Levene's is less than .05 then you read the bottom line. If it is more than .05 (which is the norm), then you read the top line.

3. Write another question that can be answered from the data using a paired t test. Run the t test and provide a full interpretation.

The problem here is understanding that paired t test are used in very particular situations. In this data set there are not many options to choose from. You should use of the paired t to compare means that use repeated measure (test – re test or pretest posttest). However, there are other factors that would cause one to believe that you would expect differences and perhaps we should be a bit more conservative in the interpretation of the results. One of those is a genetic link. In this case we have data related to height and same sex parent height. There is good reason to believe that there would be a strong correlation between those two variables. Hint Hint!

Selection of the Statistic

The choice of a statistic for Problem 10.1 has three important considerations:

- One dichotomous/nominal independent variable (gender)
- One scale (normally distributed) dependent variable (student height)
- The problem is to *compare* the average (or mean) DV scores of two independent groups (IV)

When investigating the difference between two unrelated groups (in this case males and females) on a scale variable (in this case it is average student height) it is appropriate to choose an independent samples *t* test.

Assumptions of the t test

1. **Variances of the two populations are equal**
2. **The dependent variable is normally distributed within each population**
3. **The data for the two groups are independent (the groups are not matched or related)**
4. **Groups are of similar size**

How to Produce the Selected SPSS Output

To answer Problem 10.1 with Windows:

- Click on Analyze ⇒ Compare Means ⇒ Independent Samples T Test
- Highlight student height in inches (the scale variable) and move it into the Test Variable(s) box by clicking on the arrow.
- Highlight gender (the dichotomous variable) and move it into the Grouping Variable box
- Click on Define Groups. This will open the Define Groups window
- Type a 1 in the Group 1 box (this is because the value for males is 1)
- Type a 2 in the Group 2 box (this is because the value for females is 2). If we had used different values for the levels of the variables, we would need to use those values
- Click on Continue and O.K.

To answer Problem 10.1 with syntax:

```
T-TEST
  GROUPS=gender(1 2)
  /MISSING=ANALYSIS
  /VARIABLES=height
  /CRITERIA=CIN(.95) .
```

SPSS Output for Problem 10.1

T-Test

Levels

Variable name

The number in each group should be approximately the same.

Group Statistics

	gender of student	N	Mean	Std. Deviation	Std. Error Mean
student height in inches	males	26	70.2308	2.8044	.5500
	females	24	64.1250	2.0708	.4227

The variances are the standard deviations squared; i.e., approximately 7.84 for males and 4.28 for females. The Levene's test in the next table checks to see if the variances are significantly different. In this case they are not.

This is the first place to look. These two columns indicate if the *assumption* that the variances are equal is violated. If Sig. is < .05, it is assumed that the variances are not equal, thus use the bottom line for the *t* test. In this case Sig. >.05 so use the top line.

Notice that there are really 2 tests here – the Levene's Test for Equality of Variances and the *t* test.

This is the significance level of the *t* value. If Sig. is <.05, then there is a difference between the 2 groups.

Independent Samples Test

		Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
student height in inches	Equal variances assumed	1.230	.273	8.697	48	.000	6.1058	.7020	4.6942	7.5173
	Equal variances not assumed			~~8.802~~	~~45.863~~	~~.000~~	~~6.1058~~	~~.6937~~	~~4.7094~~	~~7.5021~~

This is the *t* value.

This is the difference between the means of the two groups – the larger this is, the more likely the *t* test will be significant, given a certain standard Error of the Difference.

Ignore the "equal variances not assumed" line in this case because the Levene's test indicated that the variances were not significantly different (p>.05). Note we crossed out this line of numbers.

Description of Output 10.1

The first table shows the mean height of the two samples or groups (males and females) to be compared and other information about each sample. The second table has two parts. The first two columns are the assumption of the Levene's Test for equality of variances; it is not significant, (F=1.23, p=.27) so equal variances are assumed. The seven columns on the right refer to the two versions of the *t* test. The top line contains the *t* that is used when variances are approximately equal. Note that the confidence interval (lower limit = 4.69, upper limit = 7.52) shows that if we did the study 100 times, 95 times the true (population) difference would fall within this interval, so we can be quite confident that the difference in heights is at least 4.69 inches. The approximate effect size (*d*) can be computed using the formula *d* = Mean difference/ *SD* pooled. In this case the mean difference is 6.11 and the pooled standard deviation is approximately 2.45 (the average of the males and female *SD*'s with males weighted a little more because there are more of them). Then 6.11 ÷ 2.5 = approximately 2.5; which is *d*, a very large effect size. To calculate *d* more exactly, you could use the following formula:

$$d = \frac{\overline{M}_A - \overline{M}_B}{\sqrt{\dfrac{(n_A - 1)SD_A^2 + (n_B - 1)SD_B^2}{n_A + n_B - 2}}}$$

Example of How to Write About Problem 10.1

Results

An independent samples *t* test was executed comparing the genders on average student height in inches. A statistically significant difference was found, t (48) = 8.70, p < .001, which indicates that the average male (M =70.23) is significantly taller than the average female (M = 64.13). The 95% confident interval indicates that the mean difference between male and female students in the population is probably between 4.69 and 7.52. The effect size (approximately 2.5) is very large according to Cohen (1988).

Discussion

One research question examined was whether males and females differed significantly in height. Males were found to be much taller than females. This could be explained by the fact that throughout history, males have been taller than females, probably due to genetic differences between the sexes (Smith, 1983). There is some evidence that over the last century both males and females became taller and that the differences between males and females are less now (Jones, 1995, Smith, 1983). Data from the Jones study, compared to the current data, seem to indicate that the gender differences in the U.S. population are considerably smaller than in the current sample.

Table 10.1[a]

Group Differences for Student Height in Inches for Male and Female Students

Mean

Standard Deviation

Degrees of Freedom

	Male n=26		Female n=24			
	M	*SD*	*M*	*SD*	t (48)	p
Student height in inches	70.23	2.80	64.13	2.07	8.70	<.001

When the p value on the SPSS printout is .000 you should report it as p <.001.

[a]Usually you would not make a table with only one t test, but if you did, it might look like this. The results written here assume that the table was not included.

10.2. Is there a difference between the number of hours students study and the hours they work? Also, is there an association between the two?

10.3 Write another question that can be answered from the data using a paired sample t test. Run the t test and provide a full interpretation.

Selection of the Statistic

Key points for the paired samples t test

- Need to have a dichotomous independent variable that is paired, or matched, in some way (e.g., husband-wife, pre-post, etc.).
- Need a scale dependent variable for which you are interested in the mean score.

How to Produce the Selected SPSS Output

To answer Problem 10.3 with Windows:

- Click on Analyze ⇒ Compare Means ⇒ Paired Samples *t* test. This will open the Paired Samples *t* test window
- Highlight student height in inches and same sex parent's height
- Click on the arrow to move them into the Paired Variable(s) box
- Click on Continue and O.K.

To answer Problem 10.3 with syntax:

```
T-TEST
  PAIRS= height  WITH pheight (PAIRED)
  /CRITERIA=CIN(.95)
  /MISSING=ANALYSIS.
```

SPSS Output for Problem 10.3

T-Test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	student height in inches	67.3000	50	3.9396	.5571
	same sex parent's height	66.7800	50	5.1042	.7218

This indicates the strength of the relationship between the heights of student-parent pairs. This is *not* the *t* test; it provides different information. See Problems 10.1 – 110.3.

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	student height in inches & same sex parent's height	50	.842	.000

This is the significance level of correlation.

This is significance of the *t* test.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference: Lower	Upper			
Pair 1	student height in inches - same sex parent's height	.5200	2.7792	.3930	-.2698	1.3098	1.323	49	.192

Size of the difference between the means.

This is the paired or related samples *t*.

Description of Output 10.3

The first table provides descriptive information about two repeated or paired scores for each participant. Or, as in this case, the same type of measure (height) for two subjects who are paired (e.g., student and parent) or matched. The purpose of the paired *t* is to compare the two means to see if they are significantly different. When using your own data it is important to remember to use a paired *t* test if there is pairing or matching between the two levels of the independent variable.

The second table provides additional information, the correlation between the two variables. It does *not* tell you whether the means in the first table are different. See Problems 10.1 to 10.3 for what it does tell you.

The right side of the last table shows the paired *t* test, degrees of freedom, and whether the difference between the two means is significant. It is not because $p = .192$. The confidence interval (-.27 to 1.31), which is presented in the middle of the last table, also indicates that the *t* is not significant because it includes zero.

Example of How to Write About Problem 10.3

Results

A paired samples *t* test was performed to compare student height in inches with same sex parent's height. No significant difference was found, $t(49) = 1.32$, $p = .192$. This indicates that parents have children who are about the same height as they are.

Discussion

The finding that students are about the same height as their parents was somewhat unexpected. Research in this area has shown that over the past 100 years children, in general, had better nutrition and health than their parents did as children (Smith & Jones, 1999). Research also indicated that on average children were taller and weighed more than children did 100 years ago (Bass, 1998). However, Bass provided some evidence that generational increases in height have leveled off in the last 20-30 years. Our finding agreed with Bass, but also might be due to sampling problems.

Table 10.3[a]

Group Differences for Height Between Matched Groups

	M	*SD*	*t* (49)	*p*
Student height in inches	67.30	3.94		
			1.32	.192
Same sex parent's height	66.78	5.10		

[a] Usually you wouldn't make a table with only one *t* test, but if you did, it might look like this.